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Sites/species relations of R. dentatus.

MULTIVARIATE STATISTICAL ANALYSIS AS A TOOL FOR IDENTIFYING SITE/SPECIES RELATIONS OF *RUMEX DENTATUS* AND ASSOCIATE SPECIES

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ABSTRACT

Rumex L is a world-wide genus of about 160 species, which are as frequent in dry and sandy soils as they are in marshes and cultivated fields. Survey of associate plant species with *Rumex dentatus* was made throughout 13 localities: 2 Mediterranean, 7 Nile Valley, 3 Oases and 1 Desert, covering a wide range of habitats in which this species grows. Data of associate plant species, mechanical, and chemical analyses of soils of these localities were treated by advanced multivariate statistical methods such as correspondence analysis and ascending hierarchic classification. This allowed the objective identification of groups of associate plant species. Some of these groups are characteristic of certain localities and others are common between two or more localities. The statistical techniques used are helpful in the characterization of these localities by either mechanical or chemical analysis as well as *Rumex dentatus* associate species.

Key Words: *Rumex*, Correspondence analysis, Ascending hierarchic classification, Multivariate statistical analysis, Site/species relations.

يضم جنس الروميكس نحو ١٦٠ نوعا عالمية الانتشار وذلك فى البيئات المختلفة مثل الاراضى الرملية والاراضى الملحية بالاضافة الى الحقول الزراعية ٠ تم حصر الانواع النباتية المصاحبة لنبات الحميض (الروميكس دنتاتس) وذلك فى ١٣ موقعا تمثل بيئات مختلفة : بيئة البحر المتوسط ـ منطقة النيل ـ الواحات ـ والصحارى وحيث تتباين المواقع تباينا واسعا فى العوامل البيئية السائدة بها ٠ استخدمت الطرق الاحصائية المتقدمة مثل التحليل التوافقى ـ التقسيم الهيراركى فى تحليل نتائج الدراسة احصائيا ٠

اظهرت نتائج الدراسة انه من الممكن استخدام الانماط المختلفة للانواع النباتية المصاحبة لنبات الحميض فى التمييز بين المواقع المختلفة التى تم دراستها ٠

INTRODUCTION

The growth of *Rumex vesicarius*, *R. cyprius*, *R. pictus* and associated species has been studied under different ecological conditions [5]. *Rumex vesicarius* is a desert annual, while *R. cyprius* and *R. pictus* are Mediterranean (semi-arid) plants. The results of that study were subjected to advanced multivariate statistical methods, such as correspondence analysis and ascending hierarchic classification. Results showed that the distribution of the three *Rumex* species is affected by climatic and by soil conditions. Similar studies on the distribution of certain plant species are well documented [3],[8],[4]. *Rumex vesicarius* and *R. cyprius* have a wide range of distribution in Egypt while *R. pictus* is confined to the Mediterranean coastal region. Four associate species are common to all the stands dominated by the *Rumex* species. These associates were *Malva parviflora, Senecio desfontainei, Emex spinosus* and *Schismus barbatus*.

The present study is deals with the ecology of a fourth species of the genus *Rumex*, R. dentatus and its associated species. This is a common weed in cultivated fields and along irri-

gation canals of the Mediterranean coastal land, Nile valley, the Oases and Sinai. The present study surveys the physical and chemical characters of the soil and the weed assemblages among which it grows.

Rumex dentatus is an annual or biennials herb with lanceolate to fiddle-shaped leaves and valved inner perianth. The valves of the inner fruiting perianth are toothed with large warts occupying the width of the valves. The number of teeth are 0-3 per valve.

Methods:

Stands were sampled in the habitats of the Mediterranean region, namely, Abu Qir (Alex) and El Rabbiya (Kafr El-Sheikh); Nile valley region, namely, Fayoumy and Kom Aushim (Fayoum); Tanta (Gharbiya); Ashmoun (Minufiya); Birkash (Giza); Benha (Qalubiya); Faqus (Sharqiya); Desert region, namely, Sadat City (Cairo-Alex. Desert road); and Oases. In each of these habitats the following data are recorded; list of associated plant species, total plant cover, partial cover of *Rumex dentatus*, and the dominant species.

Soil samples were collected, air dried, passed through 2 mm sieve and packed in paper bags ready for analysis. Physical properties studied were, granulometric analysis, using the pipette method[1] and soil moisture factors, namely, water content, hygroscopic water and total water holding capacity, all expressed as percent of the oven-dry weight of the soil. In the determination of the water holding capacity, Helgard pans were used.

For chemical analysis of soil samples, a 1:5 water extract of the soil was employed for the pH value using Orion research model; EC using WPcM25 conductivity meter, calculated as m.mhos[2]. Total soluble salts, calculated from Electric Conductivity data[7], water soluble salts, using methods described

by[(1),(7),(2)]. Organic matter content estimated by Walkely and Black rapid titration method[(1)] and calcium carbonate content, using calcimeter.

Treatment of data:

Data of the present study were treated by multivariate statistical methods, correspondence analysis (CA) and ascending hierarchic classification (AHC). For detailed explanation of CA see[(6)] and for AHC see[(9)]. The computer calculation for CA and AHC were carried out at Cairo University using BIOMECO programme 3.51[(10)] developed for IBM, and allowing for the application of disjunctive coding method. This method comprises the categorization of data into groups or intervals. The number of categories varies according to the need for such study, ranging from 2 up to 5 categories with varying border as is desired. Disjunctive coding is a useful tool when dealing with different units and kinds of environmental conditions. This techniques was used prior to the application of CA and AHC.

RESULTS AND DISCUSSION

Table (1) presents the granulometric analysis of soils supporting *Rumex dentatus* and its associate plant species. It is evident that this species may grow in habitat types with a wide range of soil-texture: coarse-, medium-, or fine-textured soil. Thus it grows in sand soils of the Mediterranean coastal region and the reclaimed desert region of Sadat City, both regions with more than 90% sand (total of coarse and fine sand fractions). It grows also on the heavy soils, near Tanta in the Middle of the Nile Delta, with 71% clay content, in Kom Aushim (Fayoum), with 46% clay content as well as in Benha with 43% clay. It also grows prosperously, sometimes very vigorously, in all other habitats of medium textured soil.

Localities supporting *R. dentatus* in the Nile valley were under irrigation, the Mediterranean localities were very close

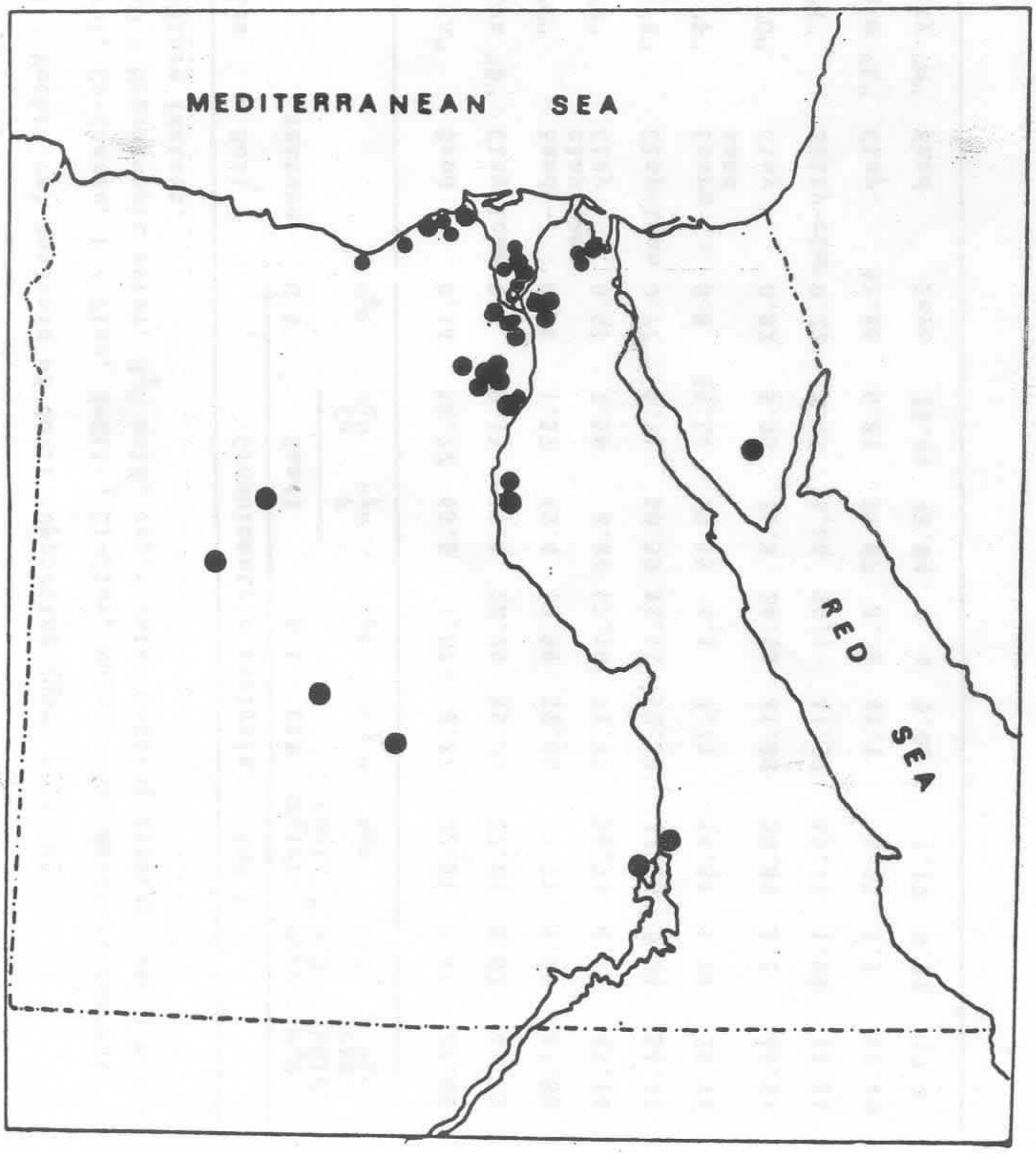

Fig. (1) Distribution map of *Rumex dentatus*.

Table (1): Mechanical Analysis of Soils supporting Rumex dentatus

G = Gravel, Co=Coarse, F = Fine, S=Silt. Cl=Clay, Moist.cont.=Moisture content. Hygr H_2O = Hygroscopic water, H_2O hold. cap.= water holding capacity and S M F = soil moisture factors.

Localities	Soil texture	Granulometric analysis					SMP %		
		G %	Sand%		S %	Cl%	Moist cont.	Hygr. H_2O	H_2O hold. cap.
			Co	F					
		"g"	"c"	"f"	"s"	"y"	"m"	"h"	"w"
Abu Qir "A"	Sand	0.14	34.72	63.8	1.07	0.27	22.51	0.47	27.88
El-Rabbiya "B"	Clay-loam	0.3	9.13	34.4	20.29	35.88	22.01	3.62	41.73
Fayoum "C"	Sandy-clayloam	0.38	1.37	45.4	19.99	32.86	7.71	1.94	47.88
Tanta "D"	Clay	0.53	2.36	8.84	17.10	71.17	36.71	4.73	43.14
Ashmoun "E"	Clay-loam	0.77	1.11	30.39	35.15	32.58	27.86	5.26	34.47
Birkash "F"	Loaym sand	0.8	58.54	29.35	4.1	7.21	14.81	1.19	23.43
Benha "G"	Clay	0.82	5.95	26.8	24.55	41.88	30.85	3.2	46.51
Faqus "H"	Silty-clay	0.22	2.45	5.66	50.1	41.57	39.22	3.99	53.33
Kom Aushim "L"	Clay.	11.66	6.81	31.97	8.[illegible]6	41.1	8.27	3.5	42.49
Sadat city "M"	Sand	Zero	55.44	43.84	0 4	0.08	1.17	0.22	17.4

to a canal in which the water level was maintained very close to the soil surface. Thus, localities of Table (1) are classified into 3 regions, Mediterranean, Nile valley, and Desert by means of disjunctive coding prior to the application of ordination techniques (Fig. 2). 92% of the total variance is associated with the first (horizontal) axis and 8% with the second (vertical) one. The first axis separates between the 3 regions. The desert region lies at left hand side of the axis and characterized by higher percentage of coarse sand. Nile Valley region lies in the opposite side (right hand side) and characterized by higher percentages of silt, clay and soil moisture factors. Mediterranean region lies at the middle of the figure (top of axis 2) and characterized by high percentage of fine sand. Gravel is of lower value in all localities except that of Kom Aushim. The sandy nature of both Desert and Mediterranean regions leads to lower values of soil moisture factors as a result of low content of inorganic colloids (silt and clay).

It is noticed that all soils supporting *R. dentatus* are slightly alkaline Table (2). pH ranging between 7.1 in Kom Aushim and 7.5 in Faqus. The content of total soluble salts (TSS) varies within a wider range, the minimum being 0.13% in Sadat City (a recently developed desert area) and the maximum is 2.49% in Kom Aushim. Application of ordination methods to data of Table (2) is shown in Fig. (3), after application of disjunctive methods as described above. 85% of the total variance is associated with the first axis and 15% with the second one. The Mediterranean region is separated and characterized by higher percentage of calcium carbonate, especially in Abu-Qir which is very close to the sea and its soil is of oolitic (limestone) origin. Desert region lies at the bottom left side of the figure and characterized by very low values of such factors of Table (2), its soil is recently reclaimed and poorly vegetated. Nile Valley region lies at the middle of the figure and surrounded by all factors. This region seems to be medium in all variables except that of calcium carbonate. El-Rabbiya locality, which is classified as Mediterranean attains a higher value of

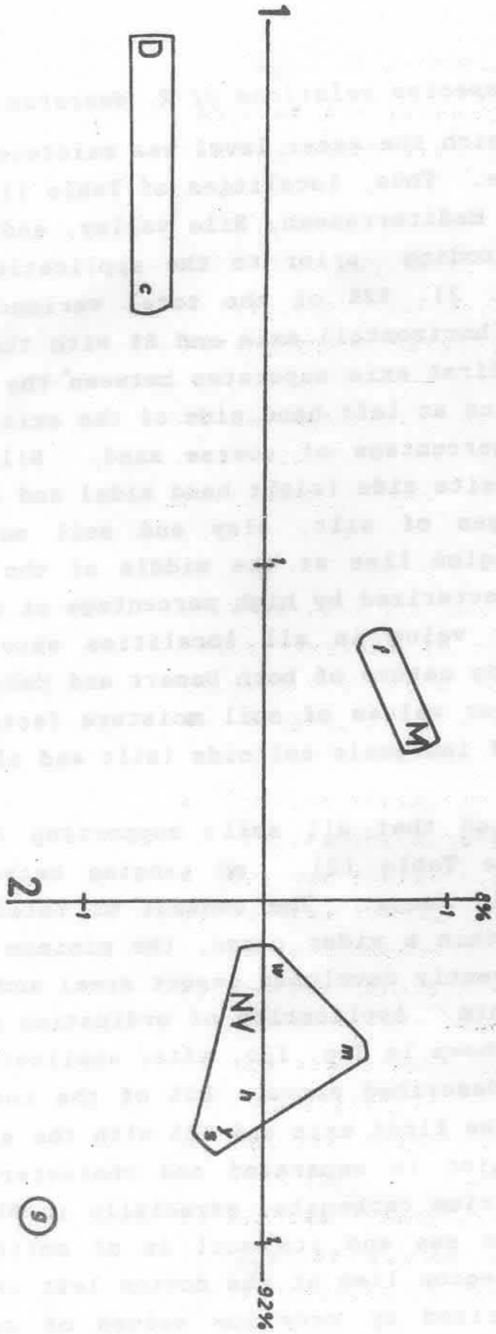

Fig. (2) Graphic representation of the application of AC and groupings by AHC methods after disjunctive coding. Symbols: M = Mediterranean, NV = Nile Valley, and D = Desert. Symbols of soil mechanical analysis and soil moisture factors are as in Table (1).

Table (2): Chemical Analysis of Soils supporting <u>Rumex</u> <u>dentatus</u>

EC=Electric conductivity, TSS=Total soluble salts and OM= Organic Matter.

Localities	pH	EC mmhos	TSS %	Cl^- %	HCO_3^{--} %	SO_4^{--} %	Ca^{2+} %	Mg^{2+} %	Na^+ %	K^+ %	OM %	$CaCO_3$ %
Abu Qir(Alex).	7.3	0.43	0.38	0.051	0.005	0.132	0.39	0.007	0.112	0.030	0.099	40.476
El-Rabbiya(Kafr El-Sheikh)	7.2	1.10	0.96	0.075	0.005	0.373	0.029	0.002	0.346	0.076	3.431	0.905
Fayoum	7.2	0.35	0.31	0.034	0.003	0.113	0.012	0.008	0.101	0.30	1.819	5.667
Tanta (Gharbiya)	7.3	1.22	1.07	0.022	0.006	0.500	0.010	0.002	0.486	0.032	2.795	6.905
Ashmoun(Minufiya)	7.3	0.30	0.26	0.013	0.004	0.113	0.015	zero	0.077	0.038	1.963	4.288
Birkash (Giza)	7.3	0.20	0.18	0.014	0.006	0.060	0.012	0.002	0.048	0.018	1.249	0.524
Benha(Qalubiya)	7.3	0.27	0.19	0.011	0.006	0.076	0.015	0.001	0.064	0.013	1.577	1.905
Faqus(Aharqiya)	7.5	0.47	0.41	0.035	0.008	0.162	0.012	0.008	0.160	0.025	1.764	4.524
Kom Aushim(Fayoum)	7.1	2.85	2.49	0.250	0.003	0.855	0.086	0.003	0.735	0.284	0.257	8.400
Sadat city(cairo - Alex. Desert	7.2	0.15	0.13	0.013	0.003	0.047	0.012	0.002	0.045	0.004	0.028	1.048

organic matter (3.43%) due to its being agricultural and densely vegetated.

Again, the disjunctive coding method was used to classify localities into 4 regions. These are: Mediterranean, Nile Valley, Desert, and Oases. Fig. (4) shows application of ordination techniques to the distributed data of associate plant species. 48% of the total variance is associated with the first axis and 30% with the second one. 11 groups were shown in this figure:

1. Species characteristic to Mediterranean region,
2. Species characteristic to Nile Valley region,
3. Species characteristic to Oases region,
4. Species characteristic to Desert region,
5. Species common between (1) and (2),
6. Species common between (2), (3), and (1), but have higher frequencies in regions (2) and (3),
7. Species common between (2) and (3) but more associated with region (3),
8. Species common between (3) and (4), but they have slightly higher frequencies in (3),
9. Species common between (2) and (4),
10. Species common between (1), (2), and (4),
11. Species common between the four regions, but species no.4 is common between (2), (3) and (4).

Numbers and names of these associate plant species are shown in the Appendix Table (1). Number of characteristic plant species for each region are in descending order: 64, 23, 18, and 3 for Nile Vallley, Oases, Desert and Mediterranean regions, respectively. Nile Valley has the highest number of plant species since localities of this region are irrigated regularly because of field crops cultivated among these localities. On the other hand, the Mediterranean region is characterized by 3 plant species only, one annual *Agrostis viridis* and two perennial species, *Phragmites australis*, and *Vigna luteola*. Other dominant

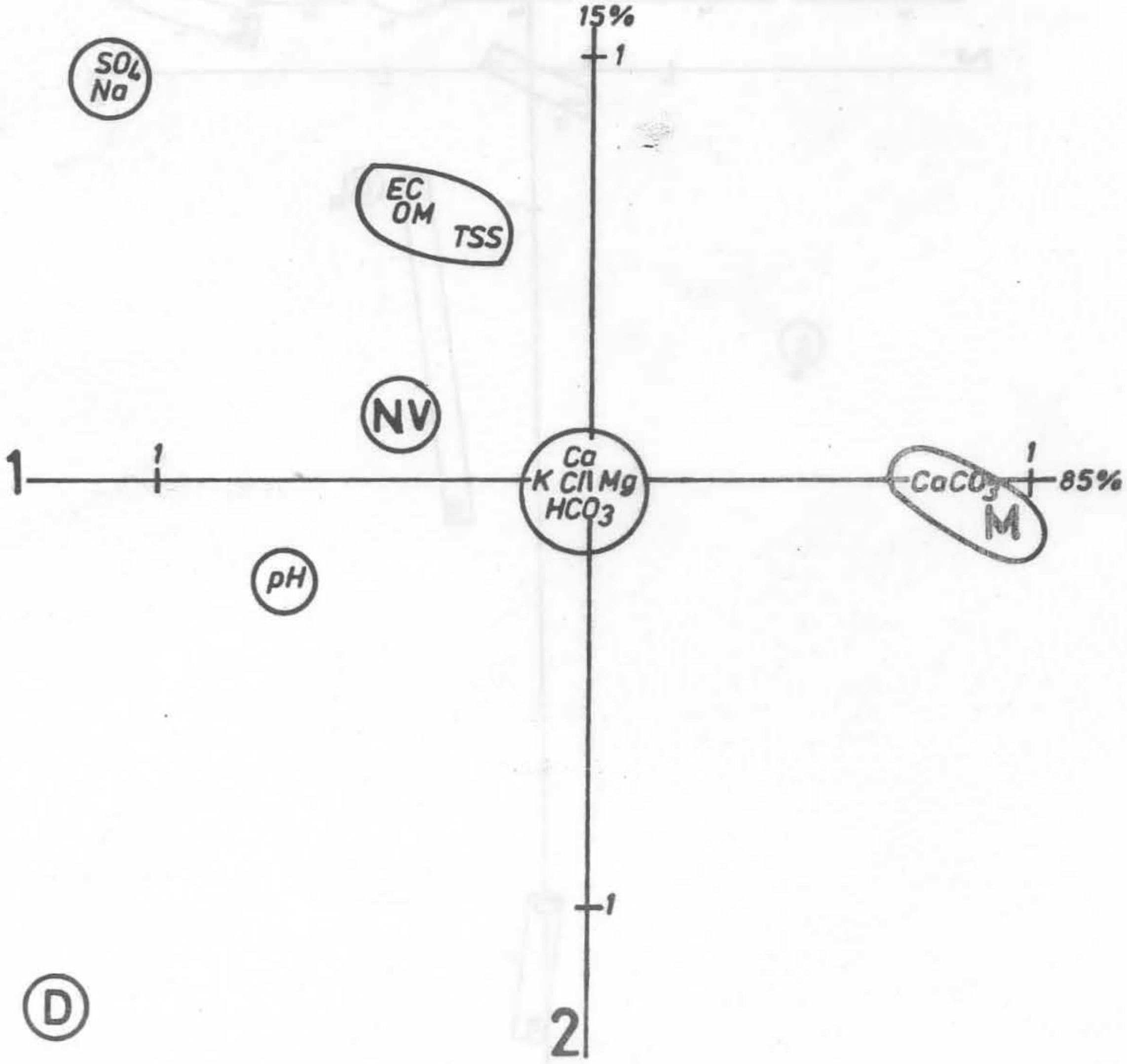

Fig. (3) Graphic representation of the application of CA and groupings by AHC methods after disjunctive coding. Symbols: M, NV, and D as in Fig. (2); EC = electric conductivity; OM = organic matter, and TSS = total soluble salts.

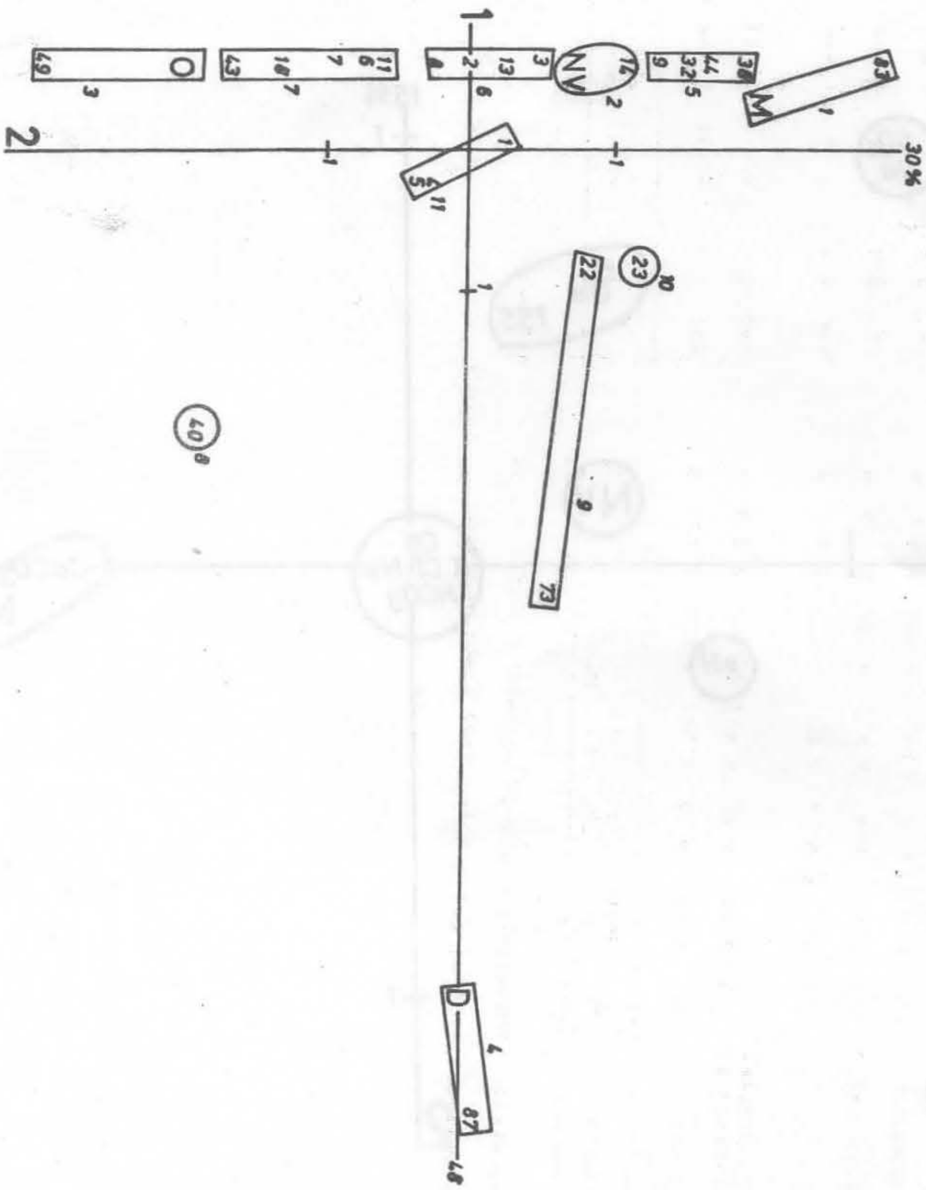

Fig. (4) Graphic representation of the application of CA and groupings by AHC methods after disjunctive coding method to data of *R. dentatus* associate plant species. Symbols: M, NV, and D are as in Fig. (1); O = Oases. Plant species (1-158) as in Appendix Table (1).

species are present, these are: *Cynodon dactylon* and *Melilotus indica* which are common to Mediterranean and Nile Valley regions.

Unfortunately, soil mechanical and chemical analysis for Oases localities were not determined. Hence the 3 localities of Oases region were eliminated from the next run. In Fig. (5), ordination was made to classify 3 regions: Mediterranean, Nile Valley and Desert regions. 68% of the total variance is associated with the first axis and 32% with second one. The first axis separates between Desert region in one side and Mediterranean and Nile Valley on the opposite side. Mediterranean and Nile Valley regions are separated along the second axis. This indicates dissimilarities among the Desert and Mediterranean and Nile Valley regions on one hand, and a higher degree of similarity between the latter two regions on the other hand. Nine groups are present in this figure. These groups are:

a) Species characteristics for Mediterranean region,
b) Species characteristics for Nile Valley region.
c) Species characteristics for Desert region,
d) Species common between (a) and (b) with equal frequencies in each region,
e) Species common between (a) and (b) with higher frequencies in region (b) than (a),
f) Species common between (a) and (b) but more associated with region (b),
g) Species common between (b) and (c) but more associated with (b),
h) Species common between (b) and (c) with equal frequencies,
i) Species common between (a), (b) and (c), with higher frequencies in region (b).

The characteristic plant species for each region are nearly the same as in Fig. (4), with exception that the characteristic plant species are 92 species. This number is larger than that of the previous treatment, this may be due to the elimination of

Oases localities, this reduces the number of common species between the Nile Valley and Oases as mentioned in Fig. (4). This species will increase the characteristic species of Nile Valley. Desert region is represented by one locality, Sadat City, characterized by 18 species (Fig. 4) and 19 species (Fig. 5). The number of associate species is higher than that of Mediterranean region, this may be attributed to the fact that seeds of these species as well as seeds of *R. dentatus* have probably been transported to that reclaimed area in contamination with the alluvial soil and animal manure brought from the Nile Valley in the reclamation processes.

Rumex dentatus is a dominant species in two localities, Tanta and Faqus. Its cover percentage is 70 and 80% for the two localities respectively, while the other associate plant hardly exceed 25%. These two localities are in the Nile Valley region. Other dominant species in the same region are *Sonchus oleraceus* (Birkash); its cover is 65% out of total cover of 70%, *Polygonum salicifolium* (Benha); with cover of 85% out of 95%, *Anagalis arvensis* (Ashmoun and Kom Aushim); its cover is 70% out of 80% in both localities and *Melilotus indica* (El Rabbiya Kafr El Sheikh and Fayoum) with cover of 90% out of total cover of 100%. *M. indica* is also dominant in desert region (Sadat City), its cover is 95% out of 100% total cover. In the Mediterranean region, the dominant species is *Cynodon dactylon* with 90% cover out of 100% total cover.

The variability in both mechanical and chemical analysis of soils of localitis of the present study does not provide a good tool in classifying these localities. But as *R. dentatus* is a weed and has wide distribution in different soils, the associate plant species may provide a better criteria for classifying such regions but not specified localities among large area. The study area includes 7 localities. This need further study in order to classify this region on the basis of species/area relations.

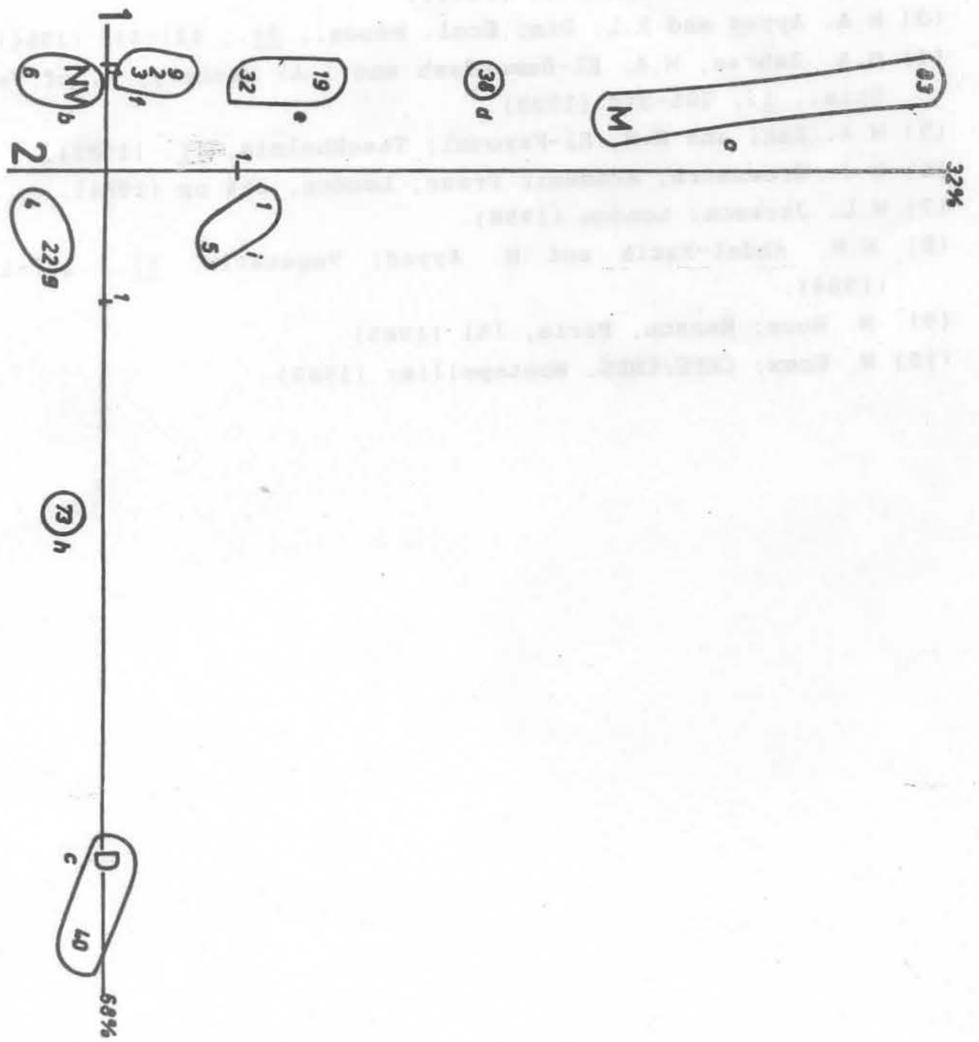

Fig. (5) Graphic representation of the application of CA and groupings by AHC methods after disjunctive coding method to data of *R. dentatus* associate plant species. Symbols: M, NV, and D are as in Appendix Table (1).

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Appendix Table (1).

	Species	Fig. 4	Fig. 5
1	*Chenopodium murale*	11	i
2	*Anagallis arvensis*	6	f
3	*Malva parviflora*	6	f
4	*Sonchus oleraceus*	11	g
5	*Melilotus indica*	11	i
6	*Brassica nigra*	7	b
7	*Avena fatua*	7	b
8	*Cichorium pumilum*	6	b
9	*Cynodon dactylon*	5	f
10	*Euphorbia peplis*	6	b
11	*Ammi majus*	7	b
12	*Beta vulgaris*	7	b
13	*Chenopodium album*	6	b
14	*Cyperus rotundus*	2	b
15	*Echinochloa colonum*	2	b
16	*Emex spinosus*	7	b
17	*Lolium perenne*	7	b
18	*Plantago lagopus*	7	b
19	*Urospermum picroides*	6	e
20	*Vicia monantha*	7	b
21	*V. sativa*	6	e
22	*Senecio desfontainei*	9	g
23	*Trifolium alexandrinum*	10	i
24	*T. resupinatum*	7	b
25	*Calendula arvensis*	7	b
26	*Capsella bursa-pastoris*	2	b
27	*Convolvulus arvensis*	2	b
28	*Euphorbia helioscopia*	7	b
29	*Lathyrus hirsutus*	6	b
30	*Medicago polymorpha*	7	b
31	*Phalaris minor*	7	b
32	*Polypogan monspeliensis*	5	e

33	*Silene rubella*	5	e
34	*Solanum nigrum*	2	b
35	*Amaranthus hybridus*	2	b
36	*Brassica tournefortii*	6	b
37	*Coronopus squamatus*	2	b
38	*Cyperus laevigatus*	5	d
39	*Eclipta alba*	2	b
40	*Launaea capitata*	8	c
41	*Lolium multiflorum*	6	b
42	*Medicago intertexta*	2	b
43	*Polygonum equisetiforme*	7	b
44	*P. salicifolium*	5	e
45	*Portulaca oleracea*	2	b
46	*Sisymbrium irio*	2	b
47	*Amaranthus viridus*	5	d
48	*Bidens pilosa*	7	b
49	*Cuscuta campestris*	3	-
50	*C. pedicellata*	7	b
51	*Cyperus difformis*	2	b
52	*Dactyloctenium aegyptium*	2	b
53	*Digitaria sanguinalis*	2	b
54	*Eleusine indica*	2	b
55	*Eruca sativa*	2	b
56	*Fumaria densiflora*	7	b
57	*Gnaphalium leuto-album*	5	d
58	*Lamium amplexicaule*	2	b
59	*Lepidium sativum*	2	b
60	*Lolium rigidum*	3	-
61	*Lycopersicon lycopersicum*	5	d
62	*Matricaria recutita*	2	b
63	*Medicago lupulina*	3	-
64	*Melilotus siculus*	2	b
65	*Mentha longifolia*	5	d
66	*Oligomeris linifolia*	7	b
67	*Oxalis corniculata*	2	b
68	*Phalaris paradoxa*	2	b
69	*Plantago major*	5	d

70	*Pluchea dioscoridis*	5	d
71	*Poa annua*	2	b
72	*Polygonum patulum*	3	-
73	*Reichardia tingitana*	9	h
74	*Scopiurus muticus*	3	-
75	*Senecio vulgaris*	7	b
76	*Stellaria media*	7	b
77	*S. pallida*	7	b
78	*Thesium humile*	3	-
79	*Torilis nodosa*	3	-
80	*Veronica anagalis-aquatica*	5	d
81	*Urtica urens*	2	b
82	*Xanthium brasilicum*	2	b
83	*Agrostis viridis*	1	a
84	*Alternanthera sessilis*	2	b
85	*Asphodelus tenuiofolius*	3	-
86	*Aster squamatus*	2	b
87	*Bassia muricata*	4	c
88	*Brachiaria mutica*	2	b
89	*B. reptans*	2	b
90	*Brassica rappa*	2	b
91	*Bromus diandrus*	3	-
92	*Centaurea calcitrapa*	3	-
93	*cotula cinerea*	4	c
94	*Coriandrum sativum*	2	b
95	*Cuscuta planiflora*	2	b
96	*Cutandia memphitica*	4	c
97	*Cynanchum acutum*	2	b
98	*Dichanthium annulatum*	4	c
99	*Dichrostachys cinera*	2	b
100	*Dinebra retroflexa*	2	b
101	*Echinochloa staginum*	2	b
102	*Eragrostis cilianensis*	4	c
103	*Erodium bryoniaefolium*	4	c
104	*Er. malacoides*	3	-
105	*Euphorbia arguta*	2	b
106	*E. hyssopifolia*	2	b

107	*E. prostrata*	2	b
108	*E. retusa*	4	c
109	*Fumaria parviflora*	2	b
110	*Gnaphalium pulvinatum*	3	-
111	*Heliotropium europaeum*	3	-
112	*Hibiscus canadensis*	2	b
113	*Iflago spicata*	4	c
114	*Imperata cylindrica*	2	b
115	*Kickxia sieberi*	3	-
116	*Launaea cassiniana*	4	c
117	*L. nudicaulis*	4	c
118	*Lolium temulentum*	3	-
119	*Lophochloa rohlfsii*	3	-
120	*Melilotus messanensis*	2	b
121	*M. sulcata*	2	b
122	*Mesembryanthemum forsskalei*	4	c
123	*Neurada procumbens*	4	c
124	*Panicum repens*	2	b
125	*Pituranthus tortuosus*	4	c
126	*Phyla nodifolia*	2	b
127	*Phragmites australis*	1	a
128	*Picris sulphurea*	3	-
129	*Polycarpon succulentum*	3	-
130	*P. tetraphyllum*	3	-
131	*Polygonum bellardii*	2	b
132	*Polypogon semiverticillatus*	2	b
133	*Polycarpaea repens*	4	c
134	*Raphanus raphanistrum*	2	b
135	*R. sativus*	2	b
136	*Sida alba*	2	b
137	*Senecio aegyptiacus*	2	b
138	*S. gallicus*	3	-
139	*Setaria glauca*	2	b
140	*S. viridus*	2	b
141	*Silene nocturna*	3	-
142	*Silybium marianum*	2	b
143	*Sinapis allionii*	2	b

144	*S. arvensis*	2	b
145	*Sonchus asper*	4	c
146	*Spergularia marina*	2	b
147	*Sporobolus spicatus*	2	b
148	*Sitpagrostis lanata*	4	c
149	*Suaeda aegyptiaca*	2	b
150	*Tamarix nilotica*	2	b
151	*T. tetragyna*	2	b
152	*Trigonella hamosa*	2	b
153	*T. stellata*	4	c
154	*Vaccaria pyramidata*	3	–
155	*Vicia lutea*	3	–
156	*Vigna luteola*	1	a
157	*Xanthium pungens*	2	b
158	*Zygophyllum coccineum*	4	c